

# Challenges And Strategies For The Improvement Of Water Management In Bhopal

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doi: 10.19044/esj.2016.v12n2p207 URL:<http://dx.doi.org/10.19044/esj.2016.v12n2p207>

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## Abstract

Bhopal is gradually being transformed into a metropolitan city due to its high developmental trajectory and its vast population size. Although she has earned the reputation of ‘City of Lake’ owing to her large number of ponds and lakes, she is insufficient in catering for the ever growing needs of her entire populace. Many natural and anthropogenic activities and occurrences such as unplanned infrastructural development, short-lived rainfall coupled with inefficient management of solid waste as well as inadequacy in skilled-manpower, are all responsible for this. In the current scenario, strategies such as the employing of technical-know-how and the engaging of Community Based Organizations are being utilized for the managing of this problem. Other invaluable efforts for the building of the social capital would be needed for the enlargement of the government’s reach in order to install the effective sustainable water management.

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**Keywords:** Solid Waste, Pollution, Community Based Organizations, Manpower

## Background of Research

### Overview of the Challenges faced by the Water Management System (with Special Reference to Bhopal)

Out of the many challenges that are continuously becoming the causes for high concerns, accessibility of most of the global population to healthy water has become one of the domineering issues for all regional, national, and international policy institutions on public health. This has been more so especially in the case of developing countries, in general and India in particular, which is relentlessly trying to get enrolled in the list of the developed nations, This is because these countries do not possess enough resources, advanced technologies, skilled manpower, and most importantly

financial prowess in the effective management of water resources. India, which has earned the recognition of becoming one of the most populous countries all over the world, is making strenuous efforts in providing clean water to all areas, both rural and urban. Metropolitan centres and other capital cities such as Bhopal, that are in the transition of becoming metropolitan due to their provision of improved urbanized infrastructure coupled with multiple ways to earn high livelihood to the people, are struggling to provide water, and healthy life to all strata of its population. Many residents of Bhopal still lack access to clean drinking water that comes under the jurisdiction of Bhopal Municipal Corporation (BMC). However, the quantity of water that is provided by the private hand pumps, and bore wells to them, more often than not, is highly polluted by chemical, and other toxic materials (Toogood & Häberli, 2009).

Currently, the water supply system in Bhopal is facing several different problems such as poor maintenance of the water tankers and surfaced pipes that refills the plastic water tanks, ruptured underground surfaced pipes at many points causing wastage of water by a heavy outflow in local areas, and irregular supply through water trucks (Toogood & Häberli 2009). In summer seasons, most of the wells in the cities cannot supply water on a regular basis because of the over extraction of underground water. Although efforts are being made by the government of Madhya Pradesh in collaboration with other bodies such as United Nations Human Settlement Program (UN-HABITAT), The Energy and Resources Institute (TERI) as well as other civil societies such as ‘Samarthan’ in finding the practical and pragmatic policy measures, more intense efforts would be required including the participation of other agents such as the citizens especially the affected communities, women and so on. Thus, this would help in improving the current conditions of the population of Bhopal.

### **Strategies Adopted by the Government's Civil Agencies, NGOs and Private Agents to Check the Constraints of Effective Water Management System in Bhopal**

Several strategies are being adopted in order to upgrade the quality of water and to improve the accessibility of a large proportion of the population of the city to a healthy water supply by the city's civil agencies in cooperation with other agents. Chief among them is the payment royal industries have to make before they are permitted to use underground water coupled with other rules and regulations made by the governmental departments responsible for managing water resources; establishing of colonies including Developing Authorities and Housing Boards for the supply of water by tube wells until unless that colony come under the jurisdiction of municipal body; installment of filtration plant where water is

being sourced through dams, ponds, and reservoirs; and revising the charges for water connection in accordance with the diameter of pipe used in water supply and the type of user (Khanna & Khanna, 2006). Consequently, it also include the initiation of effective partnership between municipal corporation of Bhopal with other entrepreneurs, Community Based Organizations (CBOs), and civil societies for curbing the water inaccessibility in colonies and towns of Bhopal(UN-HABITAT 2007)

### **Aims and Objectives of the Study**

- To explore the challenges faced by various responsible bodies such as civil agencies, NGOs, private players, and individuals in the maintenance of water management in Bhopal.
- To determine the strategies initiated by these bodies in checking those challenges.
- To determine individual level initiatives taken by residents in contributing towards water management in the area.

### **Research Methodology**

Use of the appropriate research methodology is one of the prerequisite conditions for achieving accurate results in attaining the above mentioned aims and objectives. The study involves quantitative and qualitative analysis wherein quantitative analysis are carried out through, statistical tool of SPSS (Version 21.0) developed by IBM. This tool is used to find the correlation between the strategies adopted by responsible bodies and its effect on water management of the city. With references to the primary data collection, two procedures were applied namely; the conducting of interviews through open-ended questionnaire (qualitative) based on the challenges existing in water management system of Bhopal with the officials who are engaged in distribution network of water supply in four civil agencies such as Bhopal Municipal Corporation (BMC), Public Health and Engineering (PHE), Town and Country Planning Organization (TCPO), and Kolar Road Municipality (KLM). In addition, a survey was conducted on 5000 residents of Old Bhopal and Kolar Road area of the city. This survey explores the strategies adopted by inhabitants and various responsible bodies such as BMC, PHE, TCPO alongside NGOs and private suppliers through the distribution of closed-ended questionnaire. In conducting the survey as well as the interviews, respondents have been selected on the basis of probability and non-probability sampling method. The validity of questionnaire has been tested through Cronbach Alpha using SPSS tool.

The entire research analysis have been spearheaded using three major approaches namely; descriptive: wherein profile and general background of the 5000 respondents have been analyzed; inferential:

wherein specific information based on responses have been analyzed through testing the hypothesis; and lastly, exploratory: wherein responses of the government representatives have been analyzed, shedding light on the challenges faced by them in the process of water management. In addition, secondary data has also been explored which includes eminent journals, books, government reports, research studies conducted by NGOs and such others, which act as supporting pillars to the primary data analysis.

## **Findings**

### **Qualitative Analysis**

#### **Profile of Officials**

Ten respondents approach were engaged in the four governmental agencies, namely: BMC, TCPO, PHE, and Kolar Road Municipality (KLM). However, Mr. L and Ms. T belong to Bhopal Metropolitan Council (BMC); Mr. B works with Kolar Road Municipality (KLM) where he supervises the distribution of water network, along with Ms. Q; Mr. A and Ms. P work as engineers with governmental civil agencies such as Town and Country Planning Organizations (TCPO); while Mr. O is entitled to look after the effective management of flood in Public & Health Engineering (PHE) along with Mr. C. Mr. Furthermore, M and Ms. K are employed in the Kolar Road Municipality (KLM). Owing to limited content of journals, excerpts of some of the officials have been mentioned.

### **Exploratory Analysis: Challenges of Water Management**

#### **Challenges in the Execution of Water Management Operation**

There are many challenges in the execution of various projects meant for water management system. In consonance with the opinion of Mr. O, “*seasonality of water resources*” whether sources belong to public or private “*affects the availability of water*”. In all the big cities of Madhya Pradesh, all water resources have dried up, or have come under severe stress due to long drought starting from the year 2002-2003 (Khanna & Khanna, 2006). Furthermore, other serious concerns for improving the water availability are, “*presence of high degree of fluorides*” existing in the available water resources because of industrial, municipal, and agriculture pollution in addition to unplanned infrastructural establishments in the city that hinders the natural flow of water streams pointed out by Mr. Q and Mr. A. The Bhoj Wetlands are also facing two problems namely, “*poor water quality, and reduced storage capacity*” due to the problem of siltation, stated by Mr. M. The quality of water is further getting affected by the inflow of sewage and solid waste in the catchment area of both lakes, expressed Mr. O. Thus, this has also been supported by the study of Bhoj Wetlands (Buric & Gault, 2011).

## Failure in Water Management System

Responses of the participants unanimously pointed out that there are many reasons which are continuously affecting the installment of effective water management system in the city. Almost 90% respondents have the opinion of *“inadequacy of skilled-man power which is required to run the projects”* that demand high technical qualifications. In addition to it, *“high operational and maintenance cost of the projects”* which are running at present in the city also acts as an *“impediment in bringing about the required economy and efficiency”* in the establishment of effective water management system, pointed out Mr. B. Another important issue in this dimension is that there is a mismatch in the demand and supply of water because of the lack of *“coordination in various departments”* engaged in water supply. This is coupled with the restraints involved in *“budgetary allocation”* for this gigantic task, and requirement of high expertise on the part of officials engaged in water supplying task, asserted Mr. L.

## Quantitative Analysis

### Demographic Profile of Respondents

Respondents who participated in the survey have varied features in accordance with their different educational standards, occupation, and age group. 71% of the respondents belonged to the age group of 30 to 50 years. The rest of the respondents either belonged to the age group between 18 to 28 years or are elders who had crossed their 50s. In the same way, female respondents of different age groups and educational qualifications have participated in this survey. Out of 44% female, 27.7% were graduates, 10% were doctoral candidates, and the rest were housewives.

### Inferential Analysis

In this section, testification of hypothesis will be conducted using the Bivariate Correlation and Linear Regression analytical model. This is achieved by employing the statistical software SPSS developed by IBM.

***Research Hypothesis1:*** *Individual initiatives undertaken by residents have no contribution towards water management of their areas.*

In order to know the impact of individual level initiatives on the water management, two factors have been chosen. First is the different individual initiatives contributed in sustainable water management. The Pearson Correlation of initiatives like turning off water while brushing, projected a value of  $\alpha = 0.803$  with significance level 0.000. Also, very conservative use of water during bath reflected the value of  $\alpha$ , 0.847, with significance level 0.000. Second factor that was kept in the consideration is factual knowledge and skills of residents involved in water management system. This parameter projects high value of correlation coefficient

$\alpha = 0.947$  with significance level of 0.000. Thus, inference can be drawn from the above analysis that there is a significantly positive correlation between individual initiatives and its impact on water management of respective area.

**Outcome:** *Positive correlation between individual level initiative and water management system of Bhopal that nullifies the assumed hypothesis.*

**Research Hypothesis 2:** *Strategies initiated by various stakeholders of water management are not effective in meeting the challenges.*

Three governmental bodies have been taken into consideration, namely; BMC, PHE, and TCPO. Thus, they are used in measuring the impact of strategies undertaken by these agencies on sustainable water management. By considering the role of BMC on water management as dependent variable, control of scarce water resources, installation of water treatment plant, and irrigation resources management shows the value of  $\alpha = 0.909$ ,  $\alpha = 0.876$ , and  $\alpha = 0.872$  with significance level of 0.000 respectively. In the same way, the roles of PHE and TCPO have been assessed. With regards to PHE, the total population under coverage with respect to sanitation program was depicted ( $\alpha = -0.866, p = 0.000$ ). Also, the role of PHE in tackling the problem of water quality in affected population was shown ( $\alpha = -0.869, p = 0.000$ ). Thus, this means that concerned department is not able to meet its responsibilities which are related to the distribution of water. The Pearson Correlation for the department TCPO against the independent variables such as operation and maintenance of water supply, solid waste, and sanitation shows moderate correlation  $\alpha = 0.367$ ,  $\alpha = 0.637$ , and  $\alpha = 0.385$ . Therefore, this denotes that the department fulfills its duties related to the operation and maintenance of water supply, sanitation, and waste water management on an average basis. While measuring the impact of private players and civil societies, independent variables such as provision of adequate water supply to each household, even distribution of water to each family have been taken into consideration. It has been found that there is a high correlation of  $\alpha = 0.430$ ,  $\alpha = 0.300$ , with significance level of 0.000. Therefore, this shows that the strategies adopted by these bodies have a significant impact on the water resources management system of Bhopal.

**Outcome:** *On the basis of the above analysis, this inference can be drawn that the performance of governmental agencies impacts the water level management. Hence, assumed research hypothesis stands nullified.*

## Findings

Bhopal is in the phase of transition to becoming a metropolitan city in India due to high level of urbanization and industrialization. This rapid pace of industrialization is resulting in the high demands of water resources and

enhanced level of environmental stress that further accentuates the scarcity of available resources due to high industrial and agricultural pollution. Although Bhopal has plenty of water bodies and is popularly known as ‘City of Lake’, but the city’s administration is getting unsuccessful in catering for the ever increasing demands of the city’s population due to several reasons (Suman & Kanti, 2014). Therefore, to cater for the needs of the citizens of Bhopal, its administration is taking the recourse of other strategies such as reaching out to alternative resources like collaboration with private contractors and employing advanced technologies in maintaining the existing water resources. Despite making intense efforts to reduce the problem of water scarcity, certain challenges and problems are there. Among them include ‘*Over Exploitation of Water Resources*’, ‘*Institutional and Governance Deficit*’, and ‘*Inadequacies of skilled-manpower*’, that curtail the management prowess of the city’s administration and hence demand urgent attention ( Das, 2012). Therefore, in addition to these efforts, it is required to build up social capital by constructing a healthy partnership between community organizations such as Farmers Organizations (FOs), and women centered Self Help Groups for augmenting the capabilities of governance.

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## APPENDIX 1: CORRELATION TABLES

Correlation Table of Individual Initiatives

		Do you contribute to sustainable water management initiative in your area?
Do you contribute to sustainable water management initiative in your area?	Pearson Correlation	1
	Sig. (2-tailed)	
	N	5000
I turn off the water while brushing	Pearson Correlation	.803**
	Sig. (2-tailed)	0.000
	N	5000
I use water conservatively while taking my bath	Pearson Correlation	.847**
	Sig. (2-tailed)	0.000
	N	5000
I try to avoid littering nearby lakes and save the aquatic habitat	Pearson Correlation	.762**
	Sig. (2-tailed)	0.000
	N	5000
I avoid the practice of water wastage	Pearson Correlation	.709**
	Sig. (2-tailed)	0.000
	N	5000
I like to preserve the rain and fresh water which is helpful during our household chore	Pearson Correlation	.819**
	Sig. (2-tailed)	0.000
	N	5000
I always repair the leaky faucets in the home within minimum time	Pearson Correlation	.799**
	Sig. (2-tailed)	0.000
	N	5000
I have been a participant in sustainable water management program and have assisted the group in water level monitoring	Pearson Correlation	.598**
	Sig. (2-tailed)	0.000
	N	5000
**. Correlation is significant at the 0.01 level (2-tailed).		

Correlation Table of BMC

		Roles of Bhopal Municipal Corporation
Roles of Bhopal Municipal Corporation	Pearson Correlation	1
	Sig. (2-tailed)	
	N	5000
Ensures the provision of pure water (for drinking purposes) with appropriate flow pressure	Pearson Correlation	.722**
	Sig. (2-tailed)	0.000
	N	5000
Control the scarce water resources	Pearson Correlation	.909**
	Sig. (2-tailed)	0.000
	N	5000
Ensures adequate water supply for domestic use	Pearson Correlation	.423**
	Sig. (2-tailed)	.000
	N	5000
Construction of irrigation structures in irrigation areas	Pearson Correlation	.876**
	Sig. (2-tailed)	0.000
	N	5000



Appropriate water allocation to each household in the locale	Pearson Correlation	.264**
	Sig. (2-tailed)	.000
	N	5000
Construction of water treatment plant	Pearson Correlation	.872**
	Sig. (2-tailed)	0.000
	N	5000
Increased productive efficiency related to water usages (e.g. agriculture, irrigation)	Pearson Correlation	.553**
	Sig. (2-tailed)	0.000
	N	5000
Infrastructural development (rainwater harvesting, prevention of flood, for example)	Pearson Correlation	.596**
	Sig. (2-tailed)	0.000
	N	5000
**. Correlation is significant at the 0.01 level (2-tailed).		

Correlation Table of PHE

		Roles of Public Health Engineering Department in Water supply and management
Roles of Public Health Engineering Department in Water supply and management	Pearson Correlation	1
	Sig. (2-tailed)	
	N	5000
Full coverage of both rural and urban population with safe drinking water supply facilities	Pearson Correlation	.913**
	Sig. (2-tailed)	0.000
	N	5000
Coverage of urban and rural population with sanitation, up to the limit determined by the GOI, 1981	Pearson Correlation	-.869**
	Sig. (2-tailed)	0.000
	N	5000
Ensuring as well as maintenance of sustainability of the systems and sources of water	Pearson Correlation	.684**
	Sig. (2-tailed)	0.000
	N	5000
Tackling the problem of water quality in affected habitations	Pearson Correlation	-.869**
	Sig. (2-tailed)	0.000
	N	5000
Preservation of quality of water by institutionalizing water quality monitoring and surveillance through a Catchment Area Approach	Pearson Correlation	.666**
	Sig. (2-tailed)	0.000
	N	5000
Undertaking measures to educate masses on the importance of sanitation and sustainability of water sources	Pearson Correlation	.566**
	Sig. (2-tailed)	0.000
	N	5000
**. Correlation is significant at the 0.01 level (2-tailed).		

Correlation Tables of TCPO

		Roles of Town and Country Planning Department in water resource management
Roles of Town and Country Planning organization in water resource management	Pearson Correlation	1
	Sig. (2-tailed)	
	N	5000
Operation and maintenance of three important benchmarks identified by the GOI— water supply, sanitation and solid waste management	Pearson Correlation	.637**
	Sig. (2-tailed)	0.000
	N	5000
Contribution in eliminating key areas like open defecation and manual scavenging	Pearson Correlation	-.821**
	Sig. (2-tailed)	0.000
	N	5000
Conducting regular field visits to understand the development taking place and the actual scenario	Pearson Correlation	.385**
	Sig. (2-tailed)	.000
	N	5000
Regular maintenance of technical options of water supply and management like small bore sewerage, simplified sewerage with decentralized waste water treatment, and mixed sanitation	Pearson Correlation	.367**
	Sig. (2-tailed)	.000
	N	5000
**. Correlation is significant at the 0.01 level (2-tailed).		

Correlation Table of NGOs

		Roles of NGOs in the area's water resource management
Roles of NGOs in the area's water resource management	Pearson Correlation	1
	Sig. (2-tailed)	
	N	5000
Imparting practical knowledge about local situations related to water	Pearson Correlation	.917**
	Sig. (2-tailed)	0.000
	N	5000
Have developed the experience on independent research of local water and health problems	Pearson Correlation	.393**
	Sig. (2-tailed)	.000
	N	5000
Inform the locales about water related problems and water resource management	Pearson Correlation	.757**
	Sig. (2-tailed)	0.000
	N	5000
Imparting technical solutions and alternatives to improve the situation	Pearson Correlation	.095**
	Sig. (2-tailed)	.000
	N	5000

Have developed expertise on implementation of low cost, environmentally sustainable, and efficient technologies	Pearson Correlation	.629**
	Sig. (2-tailed)	0.000
	N	5000
Empowering women to act for improving the access to safe water and manage water resources	Pearson Correlation	.760**
	Sig. (2-tailed)	0.000
	N	5000
**. Correlation is significant at the 0.01 level (2-tailed).		

Correlation Table of Private Players

		Roles of Private Water Suppliers
Roles of Private Water Suppliers	Pearson Correlation	1
	Sig. (2-tailed)	
	N	5000
Is its service required frequently by the residents?	Pearson Correlation	.942**
	Sig. (2-tailed)	0.000
	N	5000
Does it provide adequate supply of water to each household?	Pearson Correlation	.430**
	Sig. (2-tailed)	.000
	N	5000
Even distribution of water among all the residents	Pearson Correlation	.300**
	Sig. (2-tailed)	.000
	N	5000
Does the organization address water leakage (if any)?	Pearson Correlation	.332**
	Sig. (2-tailed)	.000
	N	5000
Is the organization aware of water resource management?	Pearson Correlation	.798**
	Sig. (2-tailed)	0.000
	N	5000
Does the organization develop infrastructure or technical solution to ensure minimal leakage of water during distribution?	Pearson Correlation	-.710**
	Sig. (2-tailed)	0.000
	N	5000
Does the organization ensure steps to harvest rain water?	Pearson Correlation	-.389**
	Sig. (2-tailed)	.000
	N	5000
**. Correlation is significant at the 0.01 level (2-tailed).		

## APPENDIX 2: QUALITATIVE QUESTIONNAIRE

### Challenges of Water Management System

1. What are the challenges you are facing to execute water management operation?

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2. What are the reasons for failure in water management system? Rate the following statements on the scale of 1-5 where strongly agreed=1, Agree=2, No comments=3, Disagreed=4, strongly disagreed=5.

	1	2	3	4	5
The reasons for failure of water resource authority are insufficient human resource; poor operation and maintenance activities; and unused instruments and devices.					
Poor infrastructure is responsible for water crisis.					
Lack of coordination between public demand and officials' expertise hamper water supply as well as water resource management system.					
Investment of private enterprise is necessary.					
Water resource management can be developed by improving policy, strategic planning, and legal framework.					
Government budget allocation and revenues of this department must be compared.					
Challenges of water resource management are not identified till now.					

## APPENDIX 3: QUANTITATIVE QUESTIONNAIRE

### Section A: Demographic Profile

1. Age
  - a) 18-28 years
  - b) 29-39 years
  - c) 40-50 years
  - d) Above 50
2. Gender
  - a) Male
  - b) Female

3. Educational Qualification
  - a) Below 10<sup>th</sup> Standard
  - b) 10<sup>th</sup> Standard
  - c) 12<sup>th</sup> Standard
  - d) Graduate
  - e) Post Graduate
  - f) PHD
4. Years of stay at Bhopal
  - a) Less than 5 years
  - b) 5-8 years
  - c) 9-12 years
  - d) More than 12 years
5. Family Size
  - a) 2-5
  - b) 6-8
  - c) More than 8
6. Source of Income
  - a) Service in Government Organization
  - b) Service in Private Organization
  - c) Self-employed
7. Income level per annum
  - a) Less than Rs. 200000/-
  - b) Rs. 200000/-Rs. 500000/
  - c) Rs. 500000/-Rs. 800000/
  - d) Above Rs. 800000/-
8. Ownership of house
  - a) Own house
  - b) Rented house

## **Section B: General Background of Citizens**

9. Resources of water supply system
  - a) Tube well
  - b) Municipality water
  - c) Water pump
10. Water consumption per day of your family
  - a) 20-50 liters
  - b) 50-80 liters
  - c) 80-110 liters
  - d) 110- 140 liters

- e) 140-170 liters
  - f) More than 170 liters
11. What is the priority for water resources?
- a) Domestic use
  - b) Industry
  - c) Energy
  - d) Environment
  - e) Growing cities
12. Are you satisfied with the water supply system of your city?
- a) Yes (If 'Yes', go to question no 13, 14, 15, 16)
  - b) No (If 'No', go to Q. 17, 18, 19 )
13. Who are the resource persons to resolve water crisis in your locality?
- a) Municipal Corporation
  - b) MLAs
  - c) NGOs
  - d) Local body
14. Do you really get the assistance for water resource problem?
- a) Yes
  - b) No
15. Is there any helpline provided for the crisis period?
- a) Yes
  - b) No
16. Does Helpline work for you 24/7?
- a) Yes
  - b) No
  - c) Not sure
17. How to develop water resource management in your area?
- a) Proper distribution of water
  - b) Developing people awareness level
  - c) Developing waste management system
  - d) The electricity bill must be different for domestic use and industrial use
  - e) All of the above
18. What are the threats related to resources?
- a) Floods
  - b) Draught
  - c) Water scarcity and quality in surface water
  - d) Water scarcity and quality in groundwater
  - e) Poor management system
  - f) Lack of co-ordination between stakeholders (BMC & PHE)

19. How can we manage water resources?
- Through monitoring the resource
  - Through knowledge sharing
  - Infrastructural development (rainwater harvesting for example)
  - Increased productive efficiency related to water usage (e.g. agriculture, irrigation)
  - Waste water treatment
  - Public participation
  - All of the above

### Section C: Water Management Strategies at Bhopal

20. Capacity building for water resource management is possible through
- Human Resource Development
  - Organizational change
  - Directive reforms
  - Cumulative participation of the three
21. Do you participate in any initiative of sustainable water management program?
- Mostly participate
  - Somewhat participate
  - Moderately participate
  - Rarely participate
  - Very rarely participate
22. Do you contribute in sustainable water management initiative in your area? Rate your initiative as strongly agree=1, Agree=2, No comments=3, Disagree=4, strongly disagree=5.

I turn off the water while I brush my teeth with toothpaste	1	2	3	4	5
I use water conservatively while taking bath.					
I try and avoid littering in nearby lakes and save the aquatic habitat.					
I avoid the practice of water wastage.					
I like to preserve the rain and fresh water which is helpful during my household chore.					
I always repair the leaky faucets in home within minimum time					
I have been a participant in sustainable water management program, and assisted the group in water level monitoring.					

23. Do you feel any impact of your initiatives towards sustainable water management?
- Strongly agree
  - Agree
  - Neutral
  - Disagree
  - Strongly disagree

24. What according to you should be done to improve the impact and reduce water crisis in your area? Rate the following statements on scale of 1-5 where, strongly agree=5, Agree=4, No comments=3, Disagree=2, strongly disagree=1.

	1	2	3	4	5
Factual knowledge and skill will help to handle water resource management system.					
Understanding of surface water and underground water enable the person to convince other people regarding the resolve of water crisis.					
Water literacy must be provided with the help of civil society.					
Motivational programs should be initiated which can improve sustainable water management					

#### Section D: Roles of NGOs in the Area's Water Resource Management

The following questions are based on 5-point Likert scale where **1** mean **strongly agree** and **5** means **strongly disagree**, with **3** being **No comments**.

	1	2	3	4	5
Imparting practical knowledge about local situations related to water					
Have developed the experience on independent research of local water and health problems					
Inform the locales about water related problems and water resource management					
Imparting technical solutions and alternatives to improve the situation					
Have developed expertise on implementation of low cost, environmentally sustainable, and efficient technologies					
Empowering women to act for improvement of the access to safe water and manage water resources.					

#### Section E: Roles of Bhopal Municipal Corporation

The following questions are based on 5-point Likert scale where **1** mean **strongly agree** and **5** means **strongly disagree**, with **3** being **No comments**.

	1	2	3	4	5
Ensures the provision of <i>pure</i> water (drinking purposes) with appropriate flow pressure					
Control the scarce water resources					
Ensure adequate water supply for domestic use					
Construction of irrigation structures in irrigation areas					
Appropriate water allocation to each household in the locale					
Construction of water treatment plant					
Increased productive efficiency related to water usages (e.g. agriculture, irrigation)					
Infrastructural development (rainwater harvesting, prevention of flood, for example)					



### Section F: Roles of Private Water Suppliers

The following questions are based on 5-point Likert scale where **1** mean **strongly agree** and **5** means **strongly disagree**, with **3** being **No comments**.

	1	2	3	4	5
Is its service required frequently by the residents?					
Does it provide adequate supply of water to each household?					
Do you provide adequate supply of water to each household?					
Even distribution of water among all the residents					
Does your organization address water leakage (if any)?					
Is your organization aware of water resource management?					
Does your organization develop infrastructure or technical solution to ensure minimal leakage of water during distribution?					
Does your organization ensure steps to harvest rain water?					

### Section G: Roles of Public Health Engineering Department in Water supply and management

The following questions are based on 5-point Likert scale where **1** mean **strongly agree** and **5** means **strongly disagree**, with **3** being **No comments**.

	1	2	3	4	5
Full coverage of both rural and urban population with safe drinking water supply facilities					
Coverage of urban and rural population with sanitation, up to the limit determined by the GOI, 1981					
Ensuring as well as maintenance of sustainability of the systems and sources of water.					
Tackling the problem of water quality in affected habitations					
Preservation of quality of water by institutionalizing water quality monitoring and surveillance through a Catchment Area Approach					
Undertaking measures to educate masses on the importance of sanitation and sustainability of water sources.					

## Section H: Roles of Town and Country Planning Department in Water Resource Management

The following questions are based on 5-point Likert scale where **1** mean **strongly agree** and **5** means **strongly disagree**, with **3** being **No comments**.

	1	2	3	4	5
Operation and maintenance of three important benchmarks identified by the GOI— water supply, sanitation, and solid waste management					
Contribution in eliminating key areas like open defecation and manual scavenging					
Conducting regular field visits to understand the development taking place and the actual scenario					
Regular maintenance of technical options of water supply and management like, small bore sewerage, simplified sewerage with decentralized wastewater treatment, and mixed sanitation.					

Any other comments

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*Thank you for your time!*